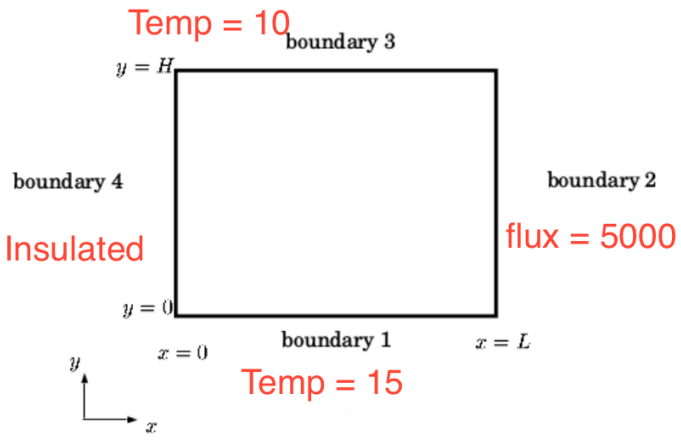
# Steady 2D Diffusion

Computational Fluid Dynamics (AM5630) Assignment 2

Mohamed Mafaz , Roll no : AM25M009

1. Mesh Geometry




L = 1

H = 0.5

T1 = 15

T2 = q= +5000

T3 = 10

T4 = dT/dx= 0−1.5 16(y/H+ 1)

STEP 1 first create a differential 2D Control Volume with

length along x deltax

length along y deltay

n required number of such differential control volumes required to construct

full CV

1.2 Computation

STEP 1 identify the boundary nodes and apply the boundary conditions

**SOUTH boundary (Dirichlet T_S) — bottom edge**

$$a_E = \frac{k_{cell}\,\Delta y}{\delta_{xe}}, \quad a_W = \frac{k_{cell}\,\Delta y}{\delta_{xw}}, \quad a_N = \frac{k_{cell}\,\Delta x}{\delta_{xn}}, \quad a_S = \frac{2k_{cell}\,\Delta x}{\delta_{xs}} \quad \text{(half-cell)}$$

Centre coefficient:

$$a_P = a_E + a_W + a_N + a_S\,.$$

RHS (source):

$$S_u = -\,1.5\,\Delta x\,\Delta y \;+\; a_S T_S\,.$$

**NORTH boundary (Dirichlet T_N) — top edge**

$$a_E = \frac{k_{cell}\,\Delta y}{\delta_{xe}}, \quad a_W = \frac{k_{cell}\,\Delta y}{\delta_{xw}}, \quad a_S = \frac{k_{cell}\,\Delta x}{\delta_{xs}}, \quad a_N = \frac{2k_{cell}\,\Delta x}{\delta_{xn}} \quad \text{(half-cell)}$$

Centre coefficient:

$$a_P = a_E + a_W + a_N + a_S\,.$$

RHS (source):

$$S_u = -\,1.5\,\Delta x\,\Delta y \;+\; a_N T_N\,.$$

**EAST boundary (Neumann flux q_E) — right edge**

Neumann: flux q_E = 5000.

$$a_N = \frac{k_{cell}\,\Delta x}{\delta_{xn}}, \quad a_S = \frac{k_{cell}\,\Delta x}{\delta_{xs}}, \quad a_W = \frac{k_{cell}\,\Delta y}{\delta_{xw}}, \quad a_E = 0 \quad \text{(no neighbor)}\,.$$

Centre coefficient:

$$a_P = a_N + a_S + a_W$$

RHS (source):

$$S_u = -1.5\,\Delta x\,\Delta y \;+\; q_E\,\Delta y \;+\; \left(a_N T_N \text{ if north boundary}\right) \;+\; \left(a_S T_S \text{ if south boundary}\right).$$

**West boundary (left edge)**

Neumann: insulated (q=0).

$$a_E = \frac{k_{cell}\,\Delta y}{\delta_{xe}}, \quad a_N = \frac{k_{cell}\,\Delta x}{\delta_{xn}}, \quad a_S = \frac{k_{cell}\,\Delta x}{\delta_{xs}}, \quad a_W = 0 \quad \text{(insulated)}.$$

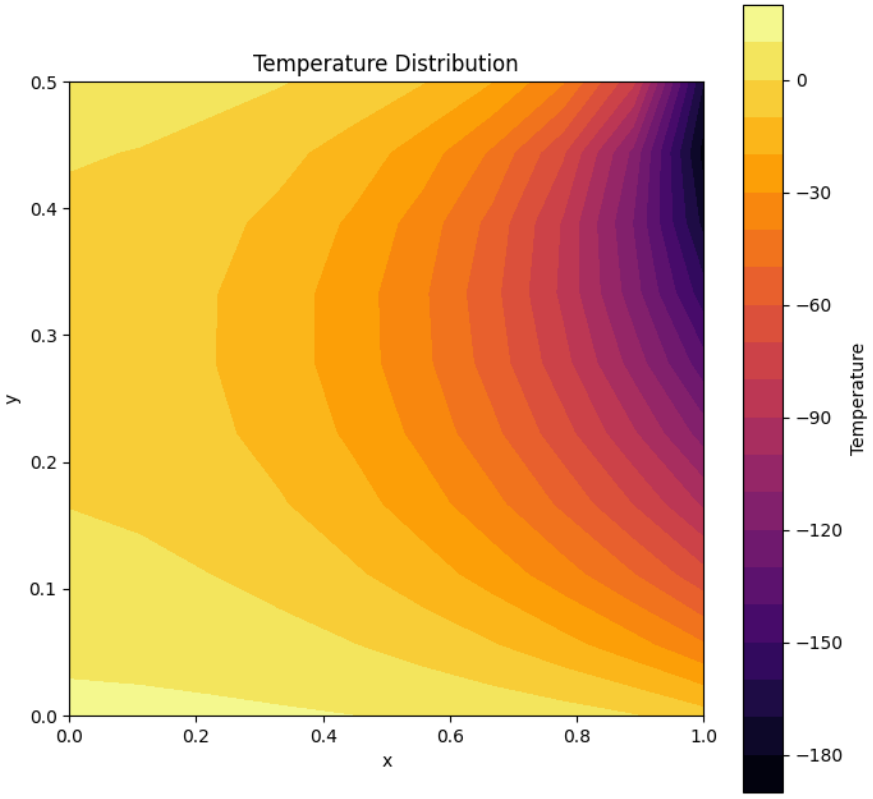
Centre coefficient:

$$a_P = a_E + a_N + a_S\,.$$

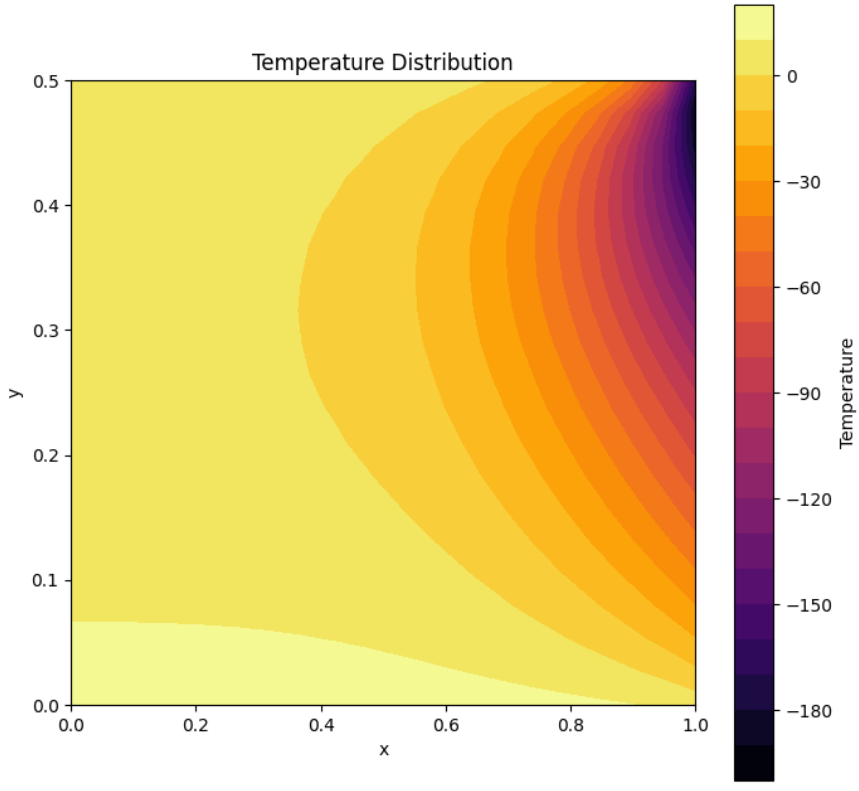
RHS (source):

$$S_u = -1.5\,\Delta x\,\Delta y \;+\; \left(a_N T_N \text{ if top-left corner}\right) \;+\; \left(a_S T_S \text{ if bottom-left corner}\right).$$

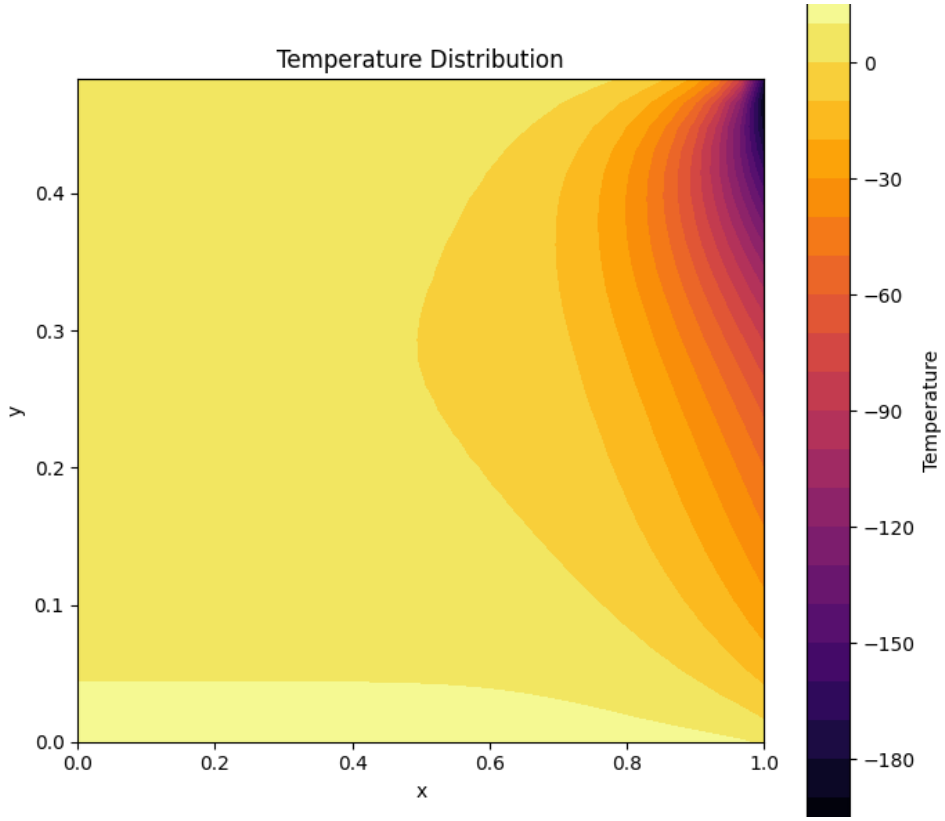
**10x10 | dx = 0.1 | dy = 0.05**



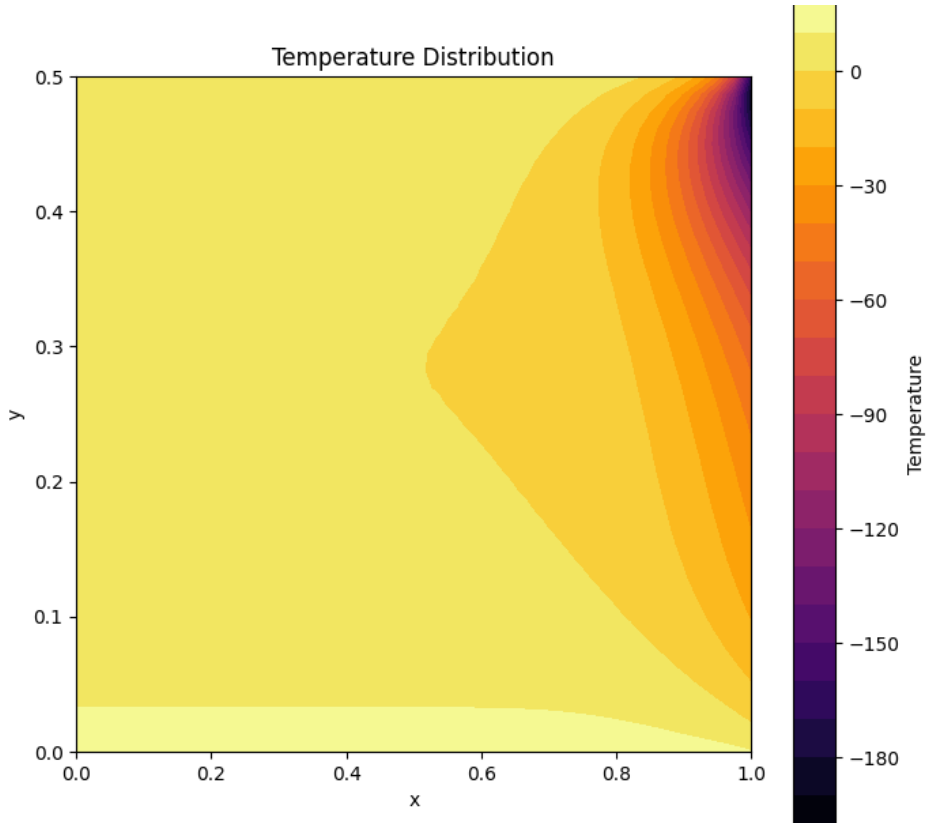

**20x20 | dx = 0.05 | dy = 0.025**

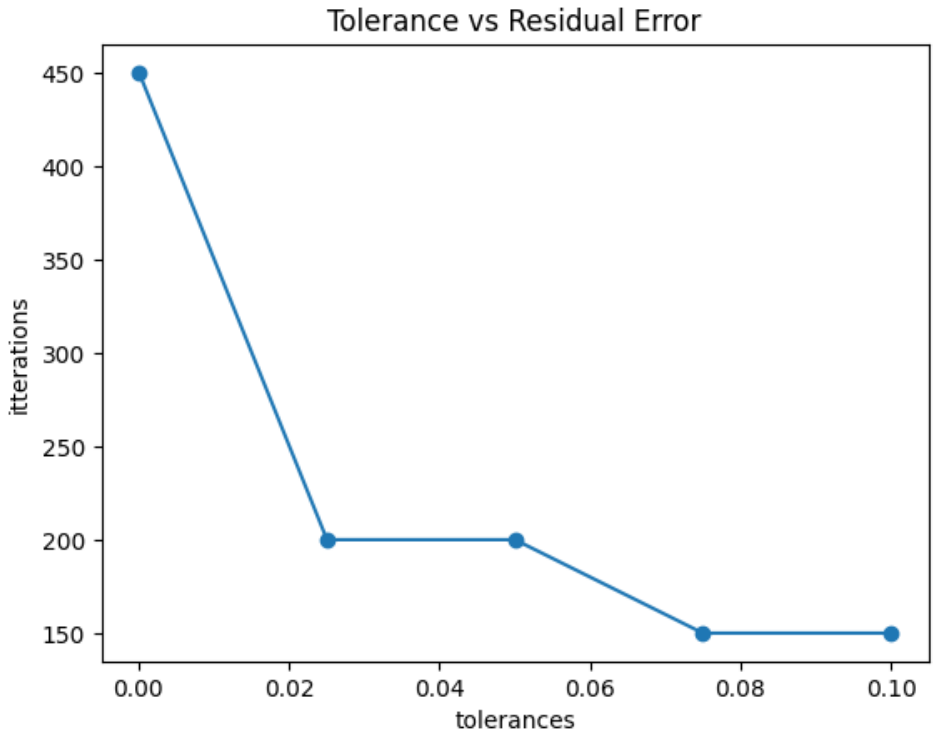


**30x30 | dx = 0.03333333333 | dy = 0.01666666667**

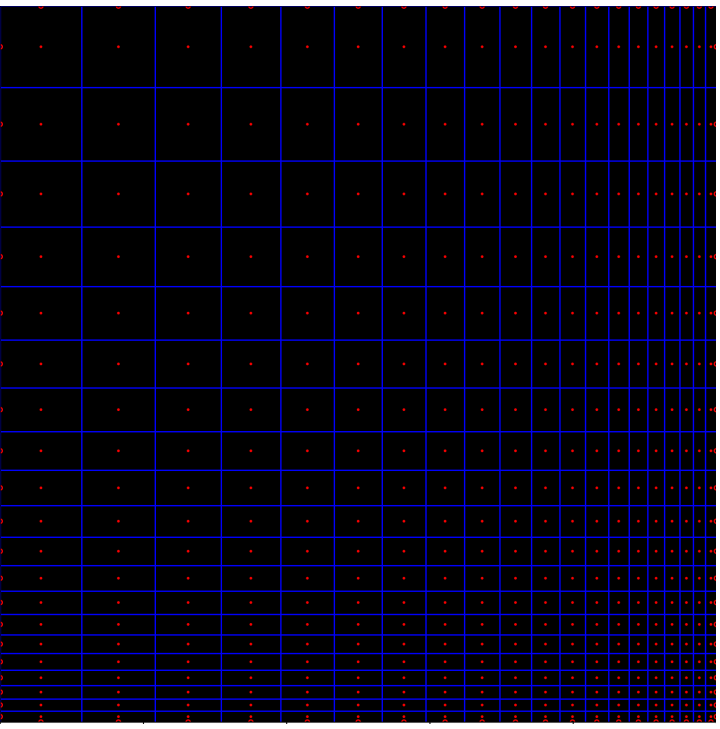


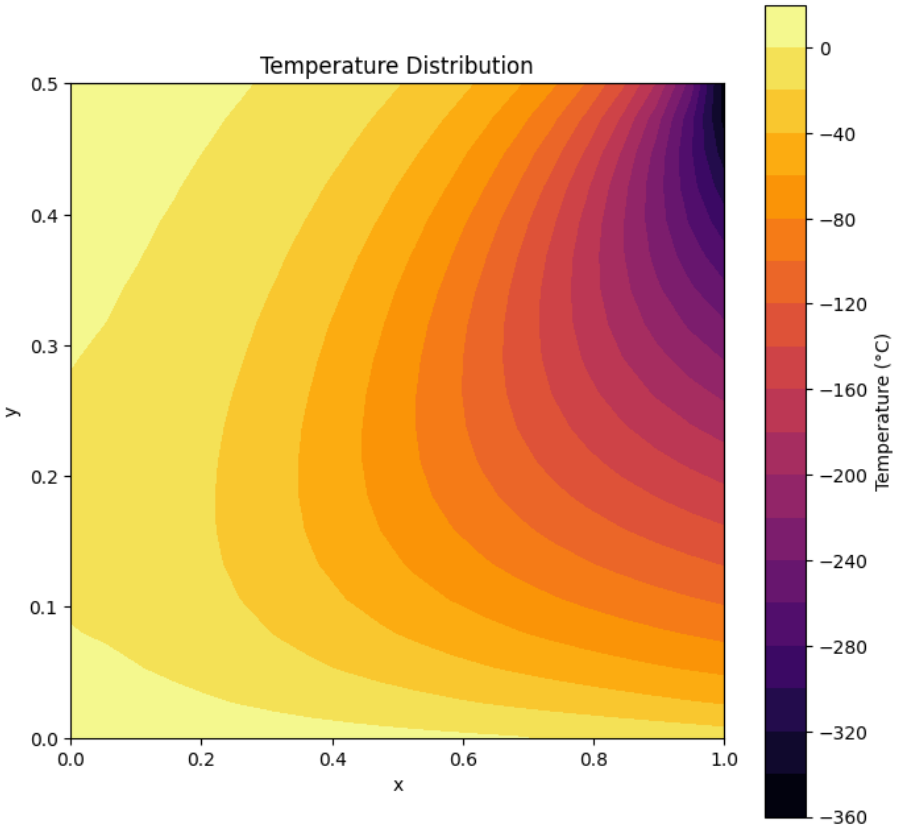

**40x40 | dx = 0.025 | dy = 0.0125**

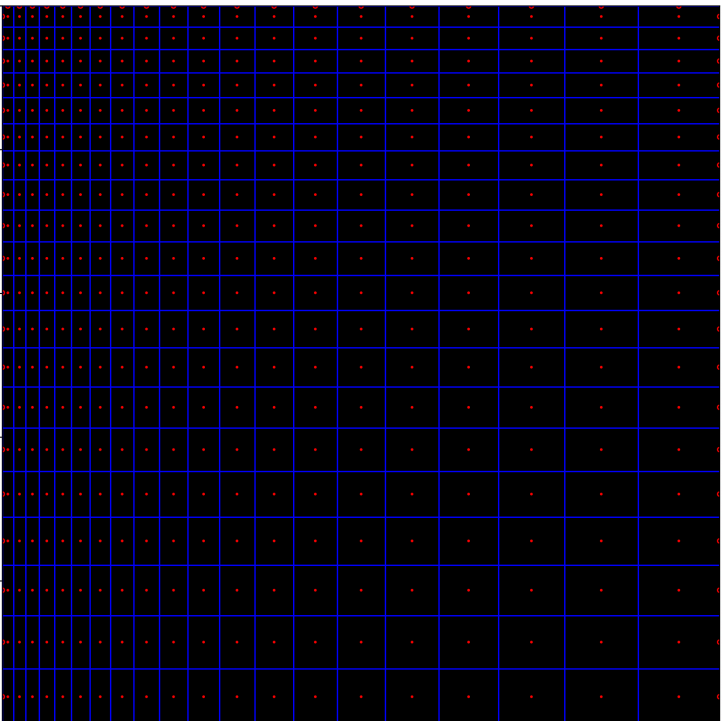


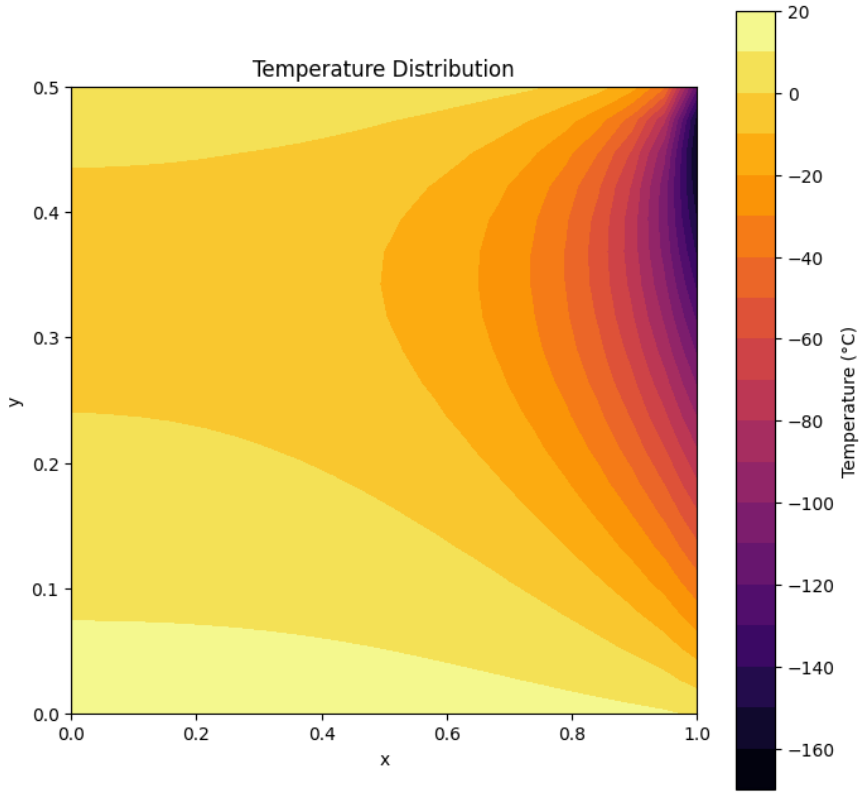



BONUS: STRECH MESH










CODE:

https://github.com/Mafaz03/Computational-Fluid-Dynamics/tree/main/2D%20Diffusion

Run the: 2D_Diffusion.ipynb